PB83-147769

Summary of Drilling Fluid Research Activities, U.S. Environmental Protection Agency, Environmental Research Laboratory, Gulf Breeze, Florida

(U.S.) Environmental Research Lab.
Gulf Breeze, FL

1982

U.S. Department of Commerce
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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3
EPA-600/D-82-364	Published Paper	PB83-147769

4. TITLE AND SUBTITLE	5. REPORT DATE
SUMMARY OF DRILLING FLUID RESEARCH ACTIVITIES U.S. Environmental Protection Agency Environmental Research Laboratory, Gulf Breeze	1982
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Thomas W. Duke	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Same as box 12.	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Environmental Research Laboratory Office of Research and Development Gulf Breeze, FL 32561	13. TYPE OF REPORT AND PERIOD COVERED
	14. SPONSORING AGENCY CODE EPA/600/04

15. SUPPLEMENTARY NOTES

Proceedings Minerals Management Service Information Meering, Agusut 24-26, 1982 in New Orleans, LA, sponsored by the Minerals Management Service, Dept. of Interior

16. ABSTRACT

Drilling-fluid related research at the U.S. EPA Environmental Research Laboratory, Gulf Breeze, is summarized. The program is conducted primarily through contracts, grants, and some inhouse projects designed to assess the potential hazard to the marine environment from fluids discharged in offshore oil and gas drilling and explorations.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release to public	Unclassified	9
	20. SECURITY CLASS *(This page)*	22. PRICE
	Unclassified	

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

EPA-600/D-82-364
PUBLISHED PAPER

SUMMARY OF

Drilling Fluid Research Activities

U.S. Environmental Protection Agency

Environmental Research Laboratory, Gulf Breeze

The Environmental Protection Agency has the responsibility to issue permits for discharge from drilling and production platforms under the National Pollutant Discharge Elimination System (NPDES) program. The conditions established for these permits are based on technical guidelines required under provisions of Section 403(c)(1) of the Clean Water Act. Drilling fluid-related research at the Environmental Research Laboratory, Gulf Breeze (ERL-GB) is conducted to provide scientific data to those involved in issuing the NPDES permits.

Drilling fluid research activities at our laboratory began in 1976 and are scheduled to terminate in 1982. The program, primarily extramural, is designed to assess the potential hazard to the marine environment from drilling fluid discharge practices. A listing of grants, contracts and in-house projects is presented in a Summary of the Drilling Fluid Hazard Assessment Program (1982).

Two recent activities sponsored by EPA are of particular interest - an Adaptive Environmental Assessment (AEA) Workshop on the Potential Impact of Drilling Fluids on the Marine Environment and a cooperative program with the Petroleum Equipment Suppliers Association and the American Petroleum Institute to screen "spent" drilling fluids obtained from wells in the Gulf of Mexico.

ADAPTIVE ENVIRONMENTAL ASSESSMENT WORKSHOP

The AEA workshop was held in 1981 in an effort to synthesize the rather large data base on the short-term effects of drilling fluids and limited

data on fate of these materials. The AEA methodology was developed by environmental scientists and system analysts at the University of British Columbia. Our workshop was attended by interested individuals from key agencies, industry and academia. Its focus was construction of a quantitative, dynamic simulation model that should be refined at later meetings. The model simulated fate and effects of discharge from a single rig into open waters of the Gulf of Mexico. Factors that might produce different fate and effects in enclosed areas, such as bays and estuaries (Aubel et al. 1982). A discharge/fate submodel dealt with discharge characteristics of the rig and subsequent fate of discharged material. Three effects submodels then calculated biological response in the water column and soft- and hard-bottom benthos. The model did not evaluate ecosystem interconnects, but focused on direct linkages between discharge and various organisms.

Results of the simulation model indicated relatively localized effects of drilling muds and cuttings from a single platform into open water areas. Fate of the fluids in the water column and their effects on selected water column organisms were dominated by rapid dilution. Effects from deposition of spent mud and cuttings were limited spatially with relatively rapid recovery, especially in soft-bottom benthic communities which were conceptualized as being adapted to frequent storms. This behavior of the model was generated by the set of assumptions about linkages and functional relationships used to construct the model. Areas of uncertainty about the model included methods for extrapolating 96-hr LC_{50} data to exposures of varying lengths and concentration; recovery rates of benthic communities; responses to various depths and rates of burial, and long-term and sublethal effects of slightly elevated concentrations of discharged materials. Evaluation of the

assumptions of the soft-bottom submodel suggest that the assumptions used may have been relatively liberal estimates of resiliency of those communities and the frequency of storms dispersing the drilling fluids.

Discussions of "closed" water bodies, such as bays and estuaries, indicated several reasons to expect different and more complex fate and effects behavior in these areas. Those factors included different species and communities (such as aquatic macrophytes and oyster beds), more complex circulation and stratification patterns and potentially more active resuspension processes. The complexity and variability of these areas notwithstanding, a large body of knowledge (such as that concerning fate and physical effects of dredge spoil) that could be effectively employed in analysis of potential fate and physical effects in enclosed areas was identified.

"SPENT" FLUID SCREENING PROGRAM

Current research activities emphasize laboratory screening of a variety of "spent" drilling fluids from wells in the Gulf of Mexico and an on-site study of plumes discharged from an operating well. In a cooperative effort, the Petroleum Equipment Suppliers Association will collect samples of the drilling fluids and send them to our laboratory, and the American Petroleum Institute will conduct duplicative screening tests on a split-sample basis.

The screening program sponsored by ERL-GB will involve chemical and biological analyses. Concentrations of nine metals, hydrocarbons and specific organics will be determined in each sample. Biological screening will include: definitive tests on soluble, suspended particulate and solid phases with Mysid shrimp; 96-hour acute and some chronic tests with grass shrimp; development of mussel larvae; development of echinoderms; and physiological studies with coral.

The National Oceanographic and Atmospheric Agency (NOAA) has been provided funds to make in-situ observations of the concentration of drilling fluid particles in a shunted discharge from an operating well. These observations will include acoutistical as well as physical and chemical measurements of the particles.

ACCOMPLISHMENTS

The following are representative of accomplishments of the ERL-GB Drilling Fluid Program:

- Evaluation of the impact of organic biocides, particularly pentachlorophenol, in drilling fluids;
- Contribution to scientific data base on fate and effects of drilling fluids through results of intro- and extramural projects;
- Synthesis of existing data on fate and effects of drilling fluid by an Adaptive Environmental Assessment Workshop;
- Provision of technical assistance for Regulatory decisions made by EPA Regional and Headquarters staff;
- State-of-the-art report on the impact of drilling fluids on the marine environment.

PERSPECTIVES

If the potential impact of drilling fluids on the marine environment is to be investigated through the use of a hazard assessment procedure (i.e., scientific judgment regarding probability of harm to the environment from known or predicted environmental concentration), it is necessary to have data on both concentration and effects. Much information has already been collected, but need for additional research was noted at the Adaptive Environmental Assessment Workshop. The following "information gaps" (except the last which originated at our laboratory) are taken from the workshop report:

- The extension of 96-hr LC_{50} data (or any fixed-concentration, fixed-interval toxicity test) to other exposure times at other, perhaps time-varying, concentrations is a central problem in estimating effects on field populations from predictions of environmental fate.
- The relationship between variation in composition of discharged drilling fluids and cuttings (e.g., variation in additives, different sites, and across time and depth at one site) and variation in toxicity does not seem to be well-established.
- Variations in the rate of recovery of disturbed benthic communities, sensitivity of these communities and their recovery rates to altered particle-size distributions, and sensitivity to depth and rate of burial are all areas where additional quantitative information is needed for model construction.
- Uncertainty exists about behavior of the plume at water stratification layers and possible effects of a potential higher concentration of discharged materials in areas where organisms might also tend to be concentrated.
- Knowledge of the limits of applicability of laboratory-derived data on fate and effects to natural field conditions is lacking.

Some of these gaps in information are being filled by present research activities sponsored by EPA, industry and others, and will appear in the final synthesis report from our laboratory. Also, information will be available from monitoring studies underway at Georges Bank and the Flower Gardens coral reefs. These additional studies will provide input for a more accurate assessment of the potential impact of drilling fluids on the marine environment.

REFERENCES

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